We claim:

1. A method for converting an input optical signal from a first wavelength to a second wavelength using a lasing semiconductor optical amplifier (LSOA) comprising an input, a laser cavity with an optical path, an amplifying path connected to the input and passing through the laser cavity, and a laser output, comprising the steps of:

inputting the input optical signal on the first wavelength to the input of the LSOA;

pumping the laser cavity of the LSOA to exceed a lasing threshold for the laser cavity;

propagating the input optical signal along the amplifying path of the LSOA; and

in response to the input optical signal propagating along the amplifying path, outputting from the laser output of the LSOA an output optical signal based on the input optical signal and having the second wavelength.

2. The method of claim 1, wherein the output optical signal is the input optical signal inverted.

3. The method of claim 1, wherein the second wavelength is determined by an optical path length of the optical path of the laser cavity of the LSOA.

4. The method of claim 3, wherein the optical path length and the second wavelength are fixed.

5. The method of claim 3, wherein the optical path length and the second wavelength are variable.

6. The method of claim 5, further comprising selecting the optical path length.

7. The method of claim 6, wherein the laser cavity of the LSOA further comprises a first mirror and a second mirror, and selecting the optical path length comprises selecting a distance between the first and second mirrors.

8. The method of claim 7, wherein the first mirror is a micro electro-mechanical system (MEMS) mirror with a variable position and selecting the distance between the first and second mirrors comprises selecting the position of the first mirror.

9. The method of claim 8, wherein the laser cavity of the LSOA further comprises a conducting layer and selecting the position of the first mirror comprises applying a selected voltage between the first mirror and the conducting layer.

10. The method of claim 6, wherein the laser cavity of the LSOA further comprises a tunable region with a selectable refractive index, and selecting the optical path length comprises selecting the refractive index of the tunable region.

11. The method of claim 1, wherein the LSOA is a vertical lasing semiconductor optical amplifier (VLSOA).

12. The method of claim 1, wherein the LSOA is a transverse lasing semiconductor optical amplifier (TLSOA).

13. The method of claim 1, wherein the LSOA is a longitudinal lasing semiconductor optical amplifier (LLSOA).

14. An apparatus for converting an input optical signal from a first wavelength to a second wavelength, comprising:

a first lasing semiconductor optical amplifier (LSOA), comprising:

an input for receiving the optical signal on the first wavelength;

a laser cavity with an optical path;

an amplifying path connected to the input and passing through the laser cavity for propagating the input optical signal;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

a laser output for outputting an intermediate optical signal in response to the input optical signal propagating through the amplifying path; and

a second LSOA, comprising:

an input coupled to the laser output of the first LSOA for receiving the intermediate optical signal from the laser output of the first LSOA;

a laser cavity with an optical path having an optical path length;

an amplifying path connected to the input and passing through the laser cavity for propagating the intermediate optical signal;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

a laser output for outputting an output optical signal in response to the intermediate optical signal propagating through the amplifying path, the output optical signal based on the input optical signal and having the second wavelength.

15. The apparatus of claim 14, wherein the second wavelength is determined by the optical path length of the laser cavity of the second LSOA.

16. The apparatus of claim 15, wherein the optical path length of the laser cavity of the second LSOA and the second wavelength are fixed.

17. The apparatus of claim 15, wherein the optical path length of the laser cavity of the second LSOA and the second wavelength are variable.

18. The apparatus of claim 17, wherein the laser cavity of the second LSOA further comprises:

a first mirror; and

a second mirror separated from the first mirror by a distance, the distance being variable.

19. The apparatus of claim 18, wherein the first mirror is a micro electro-mechanical system (MEMS) mirror with a variable position.

20. The apparatus of claim 19, wherein the laser cavity of the second LSOA further comprises a conducting layer for varying the position of the first mirror by applying a selected voltage between the first mirror and the conducting layer.

21. The apparatus of claim 17, wherein the laser cavity of the second LSOA further comprises a tunable region with a selectable refractive index.

22. The apparatus of claim 14, wherein the first LSOA is a vertical lasing semiconductor optical amplifier (VLSOA).

23. The apparatus of claim 14, wherein the first LSOA is a transverse lasing semiconductor optical amplifier (TLSOA).

24. The apparatus of claim 14, wherein the first LSOA is a longitudinal lasing semiconductor optical amplifier (LLSOA).

25. A method for converting an input optical signal from a first wavelength to a second wavelength using a first lasing semiconductor optical amplifier (LSOA) and a second LSOA, each of the first and second LSOAs comprising an input, a laser cavity with an optical path having an optical path length, an amplifying path connected to the input and passing through the laser cavity, and a laser output, comprising the steps of:

receiving the input optical signal on the first wavelength at the input of the first LSOA;

pumping the laser cavity of the first LSOA to exceed a lasing threshold for the laser cavity of the first LSOA;

propagating the input optical signal along the amplifying path of the first LSOA;

in response to the input optical signal propagating along the amplifying path, outputting from the laser output of the first LSOA an intermediate optical signal;

receiving the intermediate optical signal at the input of the second LSOA;

pumping the laser cavity of the second LSOA to exceed a lasing threshold for the laser cavity of the second LSOA;

propagating the intermediate optical signal along the amplifying path of the second LSOA; and

in response the intermediate optical signal propagating along the amplifying path, outputting from the laser output of the second LSOA an output optical signal, the output optical signal based on the input optical signal and having the second wavelength.

26. The method of claim 25, wherein the second wavelength is determined by the optical path length of the laser cavity of the second LSOA.

27. The method of claim 26, wherein the optical path length of the laser cavity of the second LSOA and the second wavelength are fixed.

28. The method of claim 26, wherein the optical path length of the laser cavity of the second LSOA and the second wavelength are variable.

29. The method of claim 28, further comprising selecting the optical path length of the laser cavity of the second LSOA.

30. The method of claim 29, wherein the laser cavity of the second LSOA further comprises a first mirror and a second mirror, and selecting the optical path length of the laser cavity of the second LSOA comprises selecting a distance between the first and second mirrors.

31. The method of claim 30, wherein the first mirror is a micro electro-mechanical system (MEMS) mirror with a variable position and selecting the distance between the first and second mirrors comprises selecting the position of the first mirror.

32. The method of claim 31, wherein the laser cavity of the second LSOA further comprises a conducting layer and selecting the position of the first mirror comprises applying a selected voltage between the first mirror and the conducting layer.

33. The method of claim 29, wherein the laser cavity of the second LSOA further comprises a tunable region with a selectable refractive index, and selecting the optical path length of the laser cavity comprises selecting the refractive index of the tunable region.

34. The method of claim 25, wherein the first LSOA is a vertical lasing semiconductor optical amplifier (VLSOA).

35. The method of claim 25, wherein the first LSOA is a transverse lasing semiconductor optical amplifier (TLSOA).

36. The method of claim 25, wherein the first LSOA is a longitudinal lasing semiconductor optical amplifier (LLSOA).

37. An apparatus for converting an input optical signal from a first wavelength to a selected second wavelength, comprising:

an input for receiving the input optical signal;

a selector for directing the input optical signal to a selected one of a plurality of lasing semiconductor optical amplifiers (LSOA), each LSOA comprising:

an input for receiving the input optical signal on the first wavelength;

a laser cavity with an optical path having an optical path length;

an amplifying path connected to the input and passing through the laser cavity for propagating the input optical signal;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

a laser output for outputting an output optical signal in response to the input optical signal propagating through the amplifying path, the output optical signal based on the input optical signal and having the second wavelength, the second wavelength being determined by the optical path length of the selected LSOA.

38. An apparatus for converting an input optical signal from a first wavelength to a second wavelength, comprising:

an input for receiving the input optical signal on the first wavelength;

a laser cavity with a selectively variable optical path length;

an amplifying path connected to the input and passing through the laser cavity for propagating the input optical signal;

a pump input connected to the laser cavity for receiving a pump that exceeds a lasing threshold for the laser cavity; and

a laser output for outputting an output optical signal in response to the input optical signal propagating through the amplifying path, the output optical signal based on the input optical signal and having the second wavelength, the second wavelength being determined by the optical path length of the laser cavity.

39. The apparatus of claim 38, wherein the output optical signal is the input optical signal inverted.

40. The apparatus of claim 38, wherein the laser cavity further comprises:

a first mirror; and

a second mirror separated from the first mirror by a distance, the distance being variable.

41. The apparatus of claim 40, wherein the first mirror is a micro electro-mechanical system (MEMS) mirror with a variable position.

42. The apparatus of claim 41, wherein the laser cavity further comprises a conducting layer for varying the position of the first mirror by applying a selected voltage between the first mirror and the conducting layer.

43. The apparatus of claim 38, wherein the laser cavity further comprises a tunable region with a selectable refractive index.

44. An apparatus for converting an input optical signal from an original wavelength to a converted wavelength, comprising:

a first output;

a second output;

a set input for receiving the input optical signal;

a reset input;

a first lasing semiconductor optical amplifier (LSOA), comprising:

an input for receiving optical signals and connected to the set input;

a laser cavity with an optical path having an optical path length;

an amplifying path connected to the input and passing through the laser cavity for propagating the optical signals received at the input;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

a laser output connected to the first output for outputting a first output optical signal on a first converted wavelength in response to the optical signals propagating through the amplifying path;

a second LSOA, comprising:

an input for receiving optical signals and coupled to the reset input and to the laser output of the first LSOA;

a laser cavity with an optical path having an optical path length;

an amplifying path connected to the input and passing through the laser cavity for propagating the optical signals received at the input;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

a laser output connected to the second output and to the input of the first LSOA for outputting a second output optical signal on a second converted wavelength in response to the optical signals propagating through the amplifying path; and

a third LSOA, comprising:

an input for receiving optical signals and coupled to the set input;

a laser cavity with an optical path having an optical path length;

an amplifying path connected to the input and passing through the laser cavity for propagating the optical signals received at the input;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

a laser output connected to the reset input for outputting a third output optical signal in response to the optical signals propagating through the amplifying path.

45. A method for converting an input optical signal from an original wavelength to a converted wavelength using a first lasing semiconductor optical amplifier (LSOA), a second LSOA, and a third LSOA, each of the first, second, and third LSOAs comprising an input, a laser cavity with an optical path having an optical path length, an amplifying path connected to the input and passing through the laser cavity, and a laser output, comprising the steps of:

receiving the input optical signal on the original wavelength at the input of the first LSOA and the input of the third LSOA;

receiving a second output optical signal from the laser output of the second LSOA at the input of the first LSOA;

pumping the laser cavity of the first LSOA to exceed a lasing threshold for the laser cavity of the first LSOA;

pumping the laser cavity of the third LSOA to exceed a lasing threshold for the laser cavity of the third LSOA;

propagating the received optical signal along the amplifying path of the first LSOA;

propagating the received optical signal along the amplifying path of the third LSOA;

in response to the received optical signal propagating along the amplifying path of the first LSOA, outputting from the laser output of the first LSOA a first output optical signal on a first converted wavelength;

in response to the received optical signal propagating along the amplifying path of the third LSOA, outputting from the laser output of the third LSOA a third output optical signal;

receiving the first output optical signal and the third output optical signal at the input of the second LSOA;

pumping the laser cavity of the second LSOA to exceed a lasing threshold for the laser cavity of the second LSOA;

propagating the received optical signals along the amplifying path of the second LSOA; and

in response to the received optical signals propagating along the amplifying path of the second LSOA, outputting from the laser output of the second LSOA the second output optical signal, the second output optical signal based on the input optical signal and having a second converted wavelength.

46. The apparatus of claim 45, further comprising receiving a clock input signal at the input of the first LSOA and the input of the third LSOA.

47. A sensitive broadband optical receiver, comprising:

a wavelength converter including an LSOA;

coupled to the wavelength converter, a filter; and

coupled to the filter, a receiver.